The next and last family of which I have notes was born August 26, 1881. I received notes of three kittens, but there may have been more :—(1) and (2) females : six toes on each fore and hind foot, as the mother. (3) sex not observed : six toes on all feet, as the mother.

After this I was unable to obtain notes, although many families were born, and a large proportion always possessed the peculiarity. Few people are aware of the immense difficulty in obtaining accurate notes of a simple observation such as this.

The mother was subsequently killed.

I now return to No. (2) of the first family, which was given to a friend on the condition that I received accurate notes of all families. I received *one* such account. This was of a family of four born in June, 1881 :—(1) male : normal. (2) female : normal. (3) female : with five toes on the fore paws, six on the hind, same as mother. (4) female : the same as mother, but five toes on the hind feet. Here again the females possess the peculiarity. The mother was also a small, very clever cat, catching birds with the most wonderful ease. There were many families, in each of which quite half possessed the peculiarity, and many of the kittens had the same number of toes as the mother.

At last, about a year ago, a female tabby kitten appeared with *seven* toes on each fore paw, and six on each hind. This was given to me, and is now a small tabby cat, with a tendency towards tortoiseshell coloration on the back. A rough drawing of the right fore foot, as seen from above and below, is seen in Figs. 1 and 2. Drawings of a normal right fore foot are given in Figs. 3 and 4, for comparison. It is seen that the extra toes are those labelled A and B, and they confer the extraordinary breadth upon the foot. The most recently added is B, which is still partially coalesced with A, and has but one pad in common with it (Fig. 2). This last toe, B, was absent in the cat which I received from Mr. Vaughan. In the first family described, Nos. (1) and (2) possessed the largely developed extra toe, A, while the insignificant pollex (Fig. 1, 1) was absent, and thus the foot appeared extremely broad, although with only the normal number of toes. In walking the pollex does not touch the ground, but the claws A and B come down a little later than the rest of the foot, making a very distinct click when the cat is walking on floorcloth. This sound is particularly audible when the cat is coming down stairs. Comparing the pads on the underside of the foot with those of a normal animal (Figs. 2 and 4), there is seen to be an extra pad behind the additional toes, of which there is no trace in the normal foot. The left foot is similar to that drawn, except that there are traces of more complete fusion between the toes A and B in the slighter tendency towards division shown by their common pad. The right hind foot from above and below is given in Figs. 5 and 6, and a normal hind foot for comparison in Figs. 7 and 8. The correlation of the toes is more difficult here, but there is little doubt that the innermost toe (Figs. 5 and 6, 1) is the hallux, lost in the normal foot.

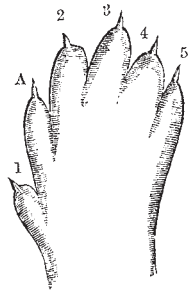

FIG. 5.—Right hind paw from above, with extra toes.

FIG. 6.—Right hind paw from below, with extra toes.

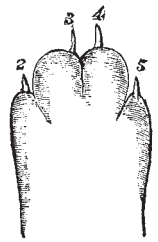

FIG. 7.—Right hind paw from above, normal.

FIG. 8.—Right hind paw from below, normal.

Comparison with the fore feet renders it likely that the second extra toe is that labelled A in Figs. 5 and 6. On the underside (Fig. 6) all the toes have separate pads, and there is an additional pad behind the extra toes. This, in the left hind foot of the same animal is fused with the pad behind the other toes.

On July 10 last the cat I have just described produced a family of four tabby kittens. Strangely enough, they are all males, but they possess the mother's peculiarity to a remarkable extent.

(1) Forepaws : exactly similar to the mother's, but toes A and B are more distinct, in that they have separate pads in both feet. Hind paws : precisely the same as the mother's, even to the fact that the left hind pads are continuous and the right hind pads slightly discontinuous (as in Fig. 6). Thus this kitten exhibits on the whole an intensification of the characters.

(2) Fore paws : the pads of the toes A and B are fused as with the mother. The claw of B is broken off, but its base is seen almost springing from the outer side of the base of claw A. Both feet the same. Thus the character is rather less developed than in the mother. Hind paws : the large hind pads are continuous on both feet. All the six toes are distinct on both feet, as with the mother, but A and 2 on the left foot are united by skin, although considerable freedom of movement is possible. Here again the character is rather less than in the mother.

(3) Fore paws : pads of A and B are distinct on the right side. The claw of B is accidentally broken off. On the left side the pads are also distinct, although the toes A and B are joined by skin. Hind paws : all six toes distinct on both feet ; the large hind pads continuous on both. Thus this kitten is beyond the mother in the separation of the pads of A and B on the fore paws. A and B were more distinct on the right side, where also in the mother the pad showed a greater tendency towards division.

(4) Fore paws : the greater tendency towards separation on the right side was very strongly marked here, inasmuch as the toe B is entirely absent on the left side, and the pad of A simple. On the right B is present, and its pad is joined to that of A, but a little more distinct than with the mother. Hind paws : all six toes distinct and large ; hind pads continuous in both feet. Thus the character is, on the whole, less than in the mother.

This is the last observation made up to the present time, and it is a very remarkable one, in the entire absence of anything approaching the normal form, and in the fact that two of the kittens go beyond the mother, while the other two are but little behind. When the two sides differ, the difference is invariably as with the mother. At the same time the immense strength of heredity in all these cases is seen when we remember that it is practically certain that the fathers of the families have always been normal. It is quite certain with this last family, for the mother was brought as a kitten from Reading to Oxford, where there is a normal male cat living in the house with her. I have never heard of cats with the abnormal number of toes in either Reading or Oxford apart from these. Mr. Vaughan says exactly the same for his cats in South Wales. Thus we must conclude that the heredity is entirely through the females, and yet the character has gone on increasing in my branch of the stock in spite of the normal element which we should expect to be introduced and to make itself felt at each stage. I have known of the family through eight generations, and three of these have started from entirely new localities (*i.e.* Haverfordwest from Bristol, Reading from Haverfordwest, Oxford from Reading) to which they were sent as kittens. This is, of course, very important, as it has prevented the possibility of interbreeding between the abnormal cats derived from the same stock.

I hope to contribute a paper to a future number upon further observations, and upon the skeletal peculiarities that accompany the abnormality.

EDWARD B. POULTON

ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY[1]

THE writer, after premising that hitherto electricity in its application to the human body had not come up to expectations reasonable in the case of so powerful a force, and

[1] Abstract of a paper read before the British Association at Southport, by W. H. Stone, M.A., F.R.C.P.

that it was evidently still in an embryonic state, mentioned some examples of the conflicting and contradictory statements made by different authorities as to its electrical resistance. These varied from 13,000 to 2875 ohms and less. He believed it was enormously overstated, and had for this reason applied himself to make some more accurate determinations. He was at once met by three obstacles:—(1) The difficulty of making good contact through the skin of a living man. (2) The limitation of the amount of current by pain, and by the fact that the rapid opening and closing of strong circuits produced a tetanic state of muscle. (3) The fact that the human body is an easy electrolyte, almost immediately furnishing currents of polarisation.

As regards (1), the axiomatic statement seemed to be that the poles must be infinitely large compared with the current they had to conduct. This condition he had attempted to fulfil in five different ways, two at least of which were successful: either by immersing the feet and hands in baths of brine in contact with an electrode of amalgamated lead or zinc of from fifty to a hundred square inches surface, or by soaking these extremities in brine, and then wrapping a strip of flexible lead two feet long by two inches wide about them, after the fashion of a surgical spiral bandage. The fact that the skin resistance was thus reduced to zero was proved to demonstration by an observation already recorded in NATURE (September 13, p. 463), from which it appeared that the resistance of a corpse, treated with the spiral leaden bandages from foot to foot was 1150 ohms, and with solid silver conductors thrust three inches deep into the plantar muscles was actually 50 ohms more.

Under the heading of contacts it was essential to determine definite anatomical points from which the measurements should start, and which readily admitted of linear verification. Such points existed in the prominence of the ulna at the inner side of the wrist, and the lower edge of the external malleolus at the ankle. The shortest course traversed by the current between these two points had been measured to a quarter of an inch.

There were three principal directions in which determinations had been made:—

1. From hand to hand.
2. From foot to foot.
3. From hand to foot.

No. 1 was much the same as the height of the subject, and was not liable to great variation.

No. 2 varied more, since the difference between very tall and shorter men lies chiefly in the legs.

No. 3 was perhaps the best test of the average conductivity of the body, since looped currents were sure to traverse the whole trunk, and even caused motor disturbance in the extremities not included in the circuit.

Three such observations were given, including one on a man of the exceptional height of nearly 8 feet.

As regards pain, it was noted that the E.M.F. used varied from three to ten bichromate cells of 1·8 volts each. Even the first was occasionally complained of, thus incidentally showing the goodness of the contact obtained. In morbid conditions, such as that termed myxœdema, the E.M.F. of 10 cells or 18 volts through a resistance of only 1260 ohms was easily borne, and indeed hardly felt. The third difficulty, that namely of electrolysis, was the most serious: indeed the particular metal of which the electrodes were made sank into insignificance compared with the rapid and vigorous polarisation of the moist tissues of the body itself. A rotating commutator on Wheatstone's plan, and afterwards a metronomic instrument, by which the periods of alternation could be varied, were first used, but with only partial success. A more delicate mode of discharging was found in the use of an ordinary commutator key worked like a piano with the index and middle fingers of the left hand; a double contact key, putting battery and galvanometer successively in circuit, being beneath the right index finger. The left keys being first depressed alternately, the right key produced a double deflection, while the bridge resistance was too low, which was replaced by an opposite double deflection when it was intentionally made too high. By watching the galvanometer a point was easily found where it ceased to "throw," and then three successive contacts in either direction were taken to determine resistance. In spite of all precautions, the second measurement was sometimes a little in excess of the first, owing to a polarisation-current assisting the battery. This, however, never amounted to more than about five ohms, and was easily allowed for. Between each set of observations a short-circuit key, inserted outside the bridge, was closed for at least a minute, so as to discharge patient, bath, and electrodes.

The measurement was then repeated with inverted current, and the mean taken.

One set of examples out of many was read to the meeting. Three men of very different heights were tested according to the following table:—

	Height.	Weight.	Ulna to malleolus.	Foot to foot.	Foot to hand.
	ft. in.	st. lb.	ft. in.		
1. Mr. Todd	5 6 ...	7 13 ...	5 9¾ ...	945 ...	1320
2. Mr. Shackel	6 3 ...	13 0 ...	7 0 ...	930 ...	1027
3. Hungarian Giant ...	7 8 ...	...	8 7 ...	930 ...	1032·5

Two of these were students at St. Thomas's Hospital; the third an Austrian now exhibiting at the Aquarium, and kindly lent to the writer for examination. All the three were singularly strong, healthy, well proportioned men, of active athletic habits. An interesting illustration of physiological laws here incidentally cropped out, showing that, in the normal human body considered as a machine, as is the length of the osseous levers so is the sectional area of the motor muscles. This in the present instance results in an almost complete identity of the electrical resistance, increased length being very fairly balanced by increased sectional area in the conductor. A good test of morbid leanness or fatness might probably be founded on this identity.

A few words only were given to the variations of human resistance in disease and with alteration of temperature. The latter have already appeared in the columns of NATURE (on June 14 and September 13).

As regards the former, six cases of hemiplegia were cited: three on the right and three on the left side of the body, in all of which the paralysed was found less resistant than the healthy side, in amounts varying from 120 to 730 ohms. The only case which differed from this rule was that of a worker in copper, from whose secretions three milligrammes of metallic copper had been extracted, where the cupreous impregnation obviously modified the general resistance of the body, as the writer had found it to do in the case of lead and mercury also.

A confirmation of the view already expressed by the writer of the paper, that the human body follows the law of solid rather than that of fluid conductors under changes of temperature, had occurred in the instance first quoted (June 14, p. 151), where the occurrence of dropsical effusion in the lower extremities permanently reduced the resistance from the values originally given, the lowest of which was 2300, to 750 ohms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

TEN lectures on the diseases of field and garden crops will be delivered by Mr. Worthington G. Smith, F.L.S., before the Institute of Agriculture, British Museum, South Kensington, during the week November 12-17. The lectures will be illustrated with actual examples, and new drawings of all the diseases from nature, uniformly enlarged to 1000 and 5000 diameters.

UNIVERSITY COLLEGE, ABERYSWYTH.—Mr. J. Brill, B.A., St. John's College, Cambridge, has been appointed lecturer to assist the Professor of Mathematics at this college. Mr. Brill was fourth wrangler in January 1882, and, we understand, had the honour of being one of the selected candidates for the Professorship of Mathematics at the University College, Cardiff.

SCIENTIFIC SERIALS

Revue d'Anthropologie (deuxième et troisième fascicules), Paris, 1883.—In the earlier of these two numbers M. Topinard continues the "Elementary Description of the Cerebral Convolutions in Man, in accordance with the Schematic Brain designed by Paul Broca." This is the second of the series of explanatory instructions begun in the January number. It ends with a description of the occipital fissures, peculiar to man, the simiæ, and lemurs, which Broca termed "scissure occipitale interne" and "scissure occipitale externe." In the simiæ the former of these is generally perpendicular, while in man it is often oblique in direction and irregular in position, rendering its determination difficult.—Under the title "*Transformisme*," a term used by French anthropologists for *Darwinism*, M. Mathias Duval gives the substance of his introductory lecture at the Anthropological School at Paris at the opening of the session of 1881–82. The lecturer, after giving a general idea of "transformism," passes in review the services rendered to the modern science of evolution by Darwin's precursors, Lamarck and Etienne Geoffroy Saint-Hilaire. Next he considers the re-